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Woodall

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(54) **MULTIMODE INVARIANT PROCESSOR**

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*) Notice Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 629 days.

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(58) Field of Search **382/103, 159, 382/173, 197, 224, 225; 348/169; 700/47, 48; 706/20; 707/7**

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,057,708 A	*	11/1977	Greeley et al.	235/413
4,396,903 A	*	8/1983	Habicht et al.	382/103
5,245,672 A	*	9/1993	Wilson et al.	382/179
5,311,600 A	*	5/1994	Aghajian et al.	382/156
5,974,163 A	*	10/1999	Kamei	382/125

OTHER PUBLICATIONS

Mills "The Continuous Retina: image processing with a single-sensor artificial neural network", IEEE, pp. 886-891, 1996.*

Imade, et al. "Segmentation and classification for mixed text/image documents using neural network", IEEE, pp. 930-934, 1993.*

Crouzil, et al. "A new correlation criterion based on gradient fields similarity", IEEE, pp. 632-636.*

Po, et al. "Directionally classified subspace image vector quantization", IEEE, pp. 336-339, 1991.*

* cited by examiner

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(57) **ABSTRACT**

A multimode invariant processor is provided to simultaneously classify one or more patterns in multidimensional or in two dimensional "real world" images. The classification is invariant to a translation, a change in scale size and a rotation of a whole or partially hidden photonic image. The multimode invariant image processor comprises a retina portion, a nonlinear processing portion, a convergence processing portion and a classifier portion. The retina portion processes the photonic image to obtain an image data array of pixels and further process the array of pixels through a window difference network to obtain gradients of the image data. The neural directors of the nonlinear processing portion receive the gradients and generate respective feature vectors, which may have a greater dimensionality than the gradient information, to aid in discrimination between similar patterns in the image data. The convergence portion processes the feature information to generate a convergence of common feature information representing at least one image feature in the image data. The classifier portion receives the common feature information and generates in response feature classification information indicating the likelihood that selected features are present in the image.

12 Claims, 6 Drawing Sheets

